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Some Aspects of the Environmental Exposure to Arsenic in Romania

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The main sources of arsenic emission in Romania are ore smelters and refineries. Arsenic determinations were carried out by the silver diethyldithiocarbamate spectrophotometric method on hair and urine samples taken from smelter workers and individuals residing in two polluted areas and three areas not polluted by arsenic. Arsenic in hair was found to be a more reliable biologic test than tests on urine, obviously reflecting the differences in arsenic concentrations in workroom air. Repeated determinations for arsenic content after 3 years revealed a twofold increased rate in the 48 re-examined workers. Hair arsenic analysis in people living in two locations near an ore smelter and a refinery indicated high levels compared to those of individuals residing in nonpolluted areas. Epidemiological studies are necessary in order to ascertain effects of heavy arsenic exposure in relation with concurrent exposures to respiratory irritants and metals.

Interest in the effects of arsenic on living organisms and in gaining a perspective on arsenic exposure has been increasing in recent years in our country.

The consequences of modern technology on the general environment determined the first investigation in 1972, after several accidents following acute arsine poisoning in workers of an ore smelting plant. In our previous paper (*1*) we reported an investigation on 127 workers exposed to arsenic as a by-product, 49 of them working in a zinc sulfate plant and 78 in cadmium–zinc refinery processing. Arsenic in the workroom and in urine and hair samples was determined by the silver diethyldithiocarbamate spectrophotometric method. Evidence of a certain degree of human contamination with arsenic was found (Table 1).

Table 1. Arsenic concentrations in urine and hair of workers from ore smelting plant.

Industrial process	Samples (*n*) Urine	Samples (*n*) Hair	Arsenic In urine, mg/l.	Arsenic In hair, μg/100g
Zinc sulfate[a,b]	49	39	0.021 ± 0.017	668.9 ± 500.9
Cadmium–zinc refinery[b,c]	78	74	0.023 ± 0.032	334 ± 401

[a]Concentrations in working area (means): As = 0.001 mg/m^{3}air, H_3As = 0.013 mg/m^3 air.
[b]Maximum permissible values: As = 0.5 mg/m^3 air, H_3As = 0.3 mg/m^3 air.
[c]Concentrations in working area (means: As = 0 mg/m^3 air, H_3As = 0.0039 mg/m^3 air.

As can be seen from Table 1, the determination of arsenic in hair is a more reliable biological test of exposure than arsenuria. Thus, as compared to arsenuria, which was within normal limits, arsenic concentration in hair exceeded the normal values reported by several authors, reflecting differences in arsenic and arsine concentrations in the workroom air at the two processing plants (*2–4*). No specific symptoms were noted in the smelter workers except slight hemolytic effects (observed in 36.6%). This could be interpreted as a consequence of occupational exposure to a complex of coexisting other metals as cadmium, lead, copper, or zinc.

In 1975, three years later, the hair of the workers engaged in the same factory was again checked for arsenic content. The results are given in Table 2. A twofold increase in arsenic concentration in the hair collected in 1975 was observed in comparison to the values obtained in 1972. This phenomenon is more evident when the arsenic content in the re-examined 48 workers is taken into account (Table 2).

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Table 2. Arsenic concentrations in hair of workers in cadmium-zinc refinery: comparison of 1972 and 1976 data.

	Total As level, $\mu g/100$ g		Workers re-examined As level, $\mu g/100$ g		
	$\mu g/100$ g	*n*	Mean	Range	*n*
1972	334 ± 401	74	287.2	20–1550	48
1975	794.4 ± 1244.7	94	730.9	27–6014	48

Only recently has investigation of the arsenic in the general environment begun. We used the hair samples to evaluate the nonoccupational human exposure to arsenic in several urban areas. It should be emphasized that three ore smelting installations and refineries are in operation in Romania. The results of hair arsenic determination in residents of five urban areas are given in Table 3.

Table 3. Hair arsenic levels in residents of five urban areas.

Age group	As level, $\mu g/100$ g Area 1[a]	Area 2[a,b]	Area 3	Area 4	Area 5
15–17 (*n* = 29)	487 (*n* = 16)	325 (*n* = 7)	—	—	37.9 (*n* = 6)
18–29 (*n* = 36)	314 (*n* = 14)	216.8 (*n* = 2)	48.7 (*n* = 7)	32.5 (*n* = 5)	27.4 (*n* = 8)
30–39 (*n* = 29)	130 (*n* = 5)	94.8 (*n* = 4)	21 (*n* = 11)	62 (*n* = 6)	43.3 (*n* = 3)
40–60 (*n* = 29)	521 (*n* = 5)	108.4 (*n* = 3)	43.3 (*n* = 6)	72.7 (*n* 13)	29.8 (*n* = 2)
Total 15–60 (*n* = 123)	363 (*n* = 40)	176.2 (*n* = 16)	37.8 (*n* = 24)	55.7 (*n* = 24)	34.8 (*n* = 19)

[a]Ore smelting area.
[b]Average As concentration in air, 3.6 $\mu g/m^3$; maximum permissible limit, 10 $\mu g/m^3$.

It is relevant that individuals living in the vicinity of ore smelters have abnormally high levels of arsenic in hair. In analyzing the arsenic concentration in samples of air in one of smelter location (Area 2) elevated values were noted, from 0.4 to 8.7 $\mu g/m^3$ air with average daily concentration of 3.6 $\mu g/m^3$ air.

Based on our preliminary data we conclude that the arsenic pollution of the environment and human beings, as a consequence of industrial development, is indeed a problem in Romania. Therefore it is worthwhile to undertake epidemiological investigations to determine the effects of high arsenic exposure, to get information on any forms of cancer, especially of the skin and lung, and possible residual effects on the central nervous system (*5*). Epidemiological studies should be carried out on populations exposed to different arsenic concentrations in ore smelting plants and in the areas surrounding them. Researches is also needed on various cocarcinogenic factors, including such materials as sulfur dioxide, lead, and cadmium, acting with arsenic on smelter workers and residents living in the vicinity of nonferrous industries. Likewise, there is an immediate and urgent need to study other sources of arsenic pollution, such as mineral water springs rich in biocarbonate (widespread in Romania), soil, and food.

Up to now our equipment has not permitted highly sensitive analyses, but we hope in the future that assistance and cooperative efforts on the methodology would allow an improvement of our methods and a comparison between our data and those of other countries.

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